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ENVIRONMENTAL IMPLICATIONS OF DESIGN CHANGES

ENVIRONMENTAL EVALUATION MEMORANDUM NO. 1

PROJECT OPTIMIZATION AND JUSTIFICATION

The text attached to this memorandum is an initial draft of the Environmental Appendix to the Engineering Report "Susitna Project - Initial Review and Evaluation, Part B: Project Optimization and Justification" presently being prepared. That report evaluates alternative development options for the Susitna Project and the Environmental Appendix considers the environmental implications of these engineering alternatives.

The information contained in this appendix, which is designed to be a self-sufficient document, has been developed from Discussion Memoranda 1, 2 and 3 (February-March 1983); review of Exhibit E of the FERC license application, as filed on 28 February 1983 (particularly chapters 3 and 10); the Acres December, 1981, Development Selection Report and Appendices; the December, 1975, Corps of Engineers Interim Feasibility Report and Appendices; the September, 1975, Corps of Engineers Draft Environmental Impact Statement for the Susitna Project; other

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project reports as identified; and further evaluations of the relative impacts of the identified engineering alternatives.

In this appendix, the comparisons of environmental impacts of alternative developments have been based on available information. The comparisons consider only those aspects which differ significantly between alternatives and therefore influence the selection of a development plan. Consideration of impacts which are similar in magnitude or which are relatively insignificant and which will not influence the selection process have not been included in this evaluation.

In reviewing and commenting on the adequancy of the evaluation presented in this appendix, it should be noted that the state and federal agencies were provided an opportunity to review and comment on a draft of the Development Selection Report in 1981. The basic comment received from ADF&G was that "it would have been a helpful process for Acres to involve ADF&G, USFWS and others in such an analysis to discuss alternative positive/negative impact possibilities. . .may have led to conclusions which were the same or potentially quite different from the Acres analysis of the situtation" (letter dated August 4, 1981). To the maximum extent possible, our present analysis needs to be sufficiently comprehensive and convincing that the conclusions are readily acceptable by all interests. Comments and information for improving the evaluation of alternative impacts are requested.

In order that this material be ready to accompany the engineering report when it is transmitted to the Alaska Power Authority, it is requested that any comments, corrections or supplemental information concerning the material contained herein be provided to E. F. Dudley by ____________________.

APPENDIX __

ENVIRONMENTAL IMPLICATIONS OF
ALTERNATIVE DEVELOPMENT CONCEPTS

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(project operation/downstream flows not available at this time)

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APPENDIX __

ENVIRONMENTAL IMPLICATIONS OF ALTERNATIVE DEVELOPMENT CONCEPTS

INTRODUCTION

Due to rather drastic changes expected in load forecasts for the Railbelt area, it is possible that sizeable changes may be required in the configuration of the Susitna Project. One aspect of the Susitna Project Optimization and Justification Study is to consider the environmental implications of possible alternative development concepts. Exhibit E of the FERC license application as filed, considers all aspects of project construction and operation in relation to probable impacts on the physical, biological and social resources of the region affected by the Project as proposed. Exhibit E has been based on the initial construction of the Watana Development with normal maximum reservoir elevation of 2185, immediately followed by construction of the Devil Canyon dam and reservoir.

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Changes in the size or configuration of project features or sequence of construction may result in different project impacts and therefore necessitate revisions to the existing environmental discussion as contained in Exhibit E. There is also the possibility that (major) changes in the design of the Project, even if these changes improve project economics and/or reduce anticipated environmental impacts, may be viewed as significant changes in project planning and therefore cause delays in the FERC license review process.

This appendix presents a discussion of the relative impacts related to each of the design and operational alternatives considered in the Project Optimization and Justificaiton Report. Following selection of a specific project configuration and operational mode, the environmental implications of the selected project will be elaborated together with necessary modifications to the Exhibit E discussion of project impacts and planned mitigation measures. A~~s~~ originally proposed, this information would be presented as an Environmental Report on all Project Design Modifications for incorporation into the (June ?) report on FERC License Application Revisions.

ENGINEERING MODIFICATIONS CONSIDERED

The Project Optimization and Justification Report examines whether the proposed Susitna Project remains the most economic project to meet the future load growth of the Railbelt Region by evaluating the following questions:

- What are the preferable timing, sequence and sizes of the Watana and Devil Canyon developments?

- Will the Watana and Devil Canyon developments provide the least-cost electricity to consumers when compared with any other projects or combinations of projects?

- Can reasonable financial arrangements be established for funding the construction of the proposed initial Watana development?

The latter two questions have relatively little, if any, purely environmental implications as considered in Exhibit E. The first question, however, introduces several alternative development schemes with potentially significant environmental implications.

Both design and operational variations have been considered as part of the Project Optimization Study. The following design options have been examined in relation to their engineering, economic, and environmental desirabilty.

- Should the maximum normal water surface elevation of the Watana Development be maintained at elevation 2185 or would a lower elevation (e.g., 2100, 2000 or 1900) be preferable?

- Should the Devil Canyon Development be built prior to the Watana Development?

- Should both developments be constructed as presently designed and scheduled with no appreciable design changes or time lag?

- Are other Susitna hydro development alternatives (e.g., construction of Watana with a tunnel to the Devil Canyon site in lieu of the dam, construction of High Devil Canyon with subsequent construction of a dam at the Vee site, etc.) viable alternatives to the proposed project?

Ten alternative project operation patterns for the Watana and Devil Canyon developments have been identified and studied to provide answers to these questions. These alternatives are identified in Table 1 and the individual developments are characterized in Table 2. In addition, potential developments at the High Devil Canyon and Vee Canyon sites have been reevaluated alone and in combinations.

Other potential development sites identified in previous studies of the hydroelectric potential of the Upper Susitna River have not been included in the present reevaluation. These sites include:

- Gold Creek,
- Olson,
- Devil Creek,
- Susitna III,

Table 1

PROJECT DESIGN ALTERNATIVES

A. Watana-Devil Canyon Alternatives

	Watana Normal Maximum Water Surface Elevation	Devil Canyon Normal Maximum Water Surface Elevation (Drawdown)
Single Development Operation		
1.	2185	---
2.	2100	---
3.	2000	---
4.	1900	---
5.	---	1455 (50 ft)
6.	---	1455 (100 ft)
Joint Development Operation		
7.	2185	1455 (50 ft)
8.	2100	1455 (50 ft)
9.	2000	1455 (50 ft)
10.	1900	1455 (50 ft)

B. Other Site Possibilities/Combinations

11. High Devil Canyon 1750
12. High Devil Canyon site but only developed to 1455 (some height as at the Devil Canyon Development)
13. Vee Canyon 2330
14.-17. High Devil Canyon 1455 plus each of the four Watana alternatives
18. High Devil Canyon 1750 plus Vee (2330)
19. Watana 1900 plus Devil Canyon (1455) plus Vee (2330)

C. Reregulating Dams

Devil Canyon R1000
High Devil Canyon R1130

POTENTIAL SUSITNA RIVER PROJECT DEVELOPMENTS
DAM AND RESERVOIR CHARACTERISTICS

EFD
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Characteristic	Development										
Development	Devil Canyon	Devil Canyon	High Devil C.	High Devil C.	High Devil C.	Watana	Watana	Watana	Watana	Vee Canyon	Vee Canyon
Normal Maximum Water Surface Elevation (Ft.)	1455	R 1000	1455	1750	R 1130	1900	2000	2100	2185	2330	2240
Dam Location (RM)	152	152	155	156	156	184	184	184	184	224	224
Maximum Surcharge Elevation (Ft.)	1466			1765		1916	2016	2116	2201	2340	2250
Dam Crest Elevation (Ft.)				1775		1925	2025	2125	2210	2350	2260
Dam Height (Ft)	635		515	810		525	625	725	810	455	365
Type of Dam Construction	Concrete Arch			Earthfill		Earthfill	Earthfill	Earthfill	Earthfill	Earthfill	Earthfill
Volume of Dam (10^6 CY)	1.3 (arch) 1.9 (fill)			48		18	29	46	62	10	
Construction Time (Years)	8			9		7	8	9	10	6	
Reservoir Area (Acres)	7,500		6,300	24 000		14 490	19 850	28 290	38 000	9 400	
Reservoir Volume (10^6 AF)	1.1		1.0	4.7		2.51	4.22	6.64	9.44	1.30	
River Length Inundated (miles)	32	3	28	56	3	39	44	49	54	36	22
Inundation Upstream To (R.M)	184	155	184	212	159	223	228	233	238	260	[illegible]
Maximum Width (miles)									5		
Maximum Drawdown (Ft.)	50			100		170	165	150	120	100	
Minimum Operating Elevation (Ft.)	1405			1650		1730	1835	1950	2065	2230	
Active Reservoir Volume (10^6 AF)	0.35			1.8		0.93	1.57	2.53	3.75	0.7	
Inactive Reservoir Volume (10^6 AF)	0.75			2.9		1.58	2.65	4.11	5.69	0.6	
Tailwater Elevation (at 15,000 cfs)	890	890	1020	1020	1020	1460	1460	1460	1460	1900	1900

- Maclaren,
- Denali,
- Butte Creek, and
- Tyone.

These sites were all eliminated from previous studies for one or more of the following reasons and there does not appear to be reason to alter this decision:

- Potential blockage of salmon migrations up to Portage Creek (Gold Creek, Olson);
- Excessive environmental impacts on big game and waterfowl (Tyone, Butte Creek, Denali, Maclaren); or
- Better alternative sites (Devil Creek, Butte Creek, Susitna III).

In all, 19 development concepts have been evaluated in terms of their ability to economically meet the electrical needs of the Railbelt Region in an environmentally acceptable manner.

Three multi-development schemes are shown schematically in Exhibit I. These are:

Bill - you already have this schematic

- the Devil Canyon - Watana 2185 scheme as described in the license application,
- High Devil Canyon - Vee Canyon, and
- Devil Canyon - Watana 1900 - Vee Canyon.

For each development concept, alternative operational modes have been considered. For any operational mode resulting in fluctuating project discharge flows, reregulating structures will be incorporated into project plans to virtually eliminate flow fluctuations. Two potential reregulating structures, at the Devil Canyon and High Devil Canyon sites, are shown in Table 2.

In terms of anticipated environmental implications of the alternatives, the development concepts will differentially impact the region upstream of Portage Creek and the operational modes will affect the river downstream from Portage Creek through differential flow release patterns.

ENVIRONMENTAL IMPLICATIONS OF DEVELOPMENT CONCEPTS

The dam and reservoir characteristics of the eight single-development alternatives, plus two reregulating structures, are presented in Table 2. The remaining development concepts are combinations of these individual developments. Individual reservoir areas range from 38,000 acres for the Watana 2185 development to 6,300 acres for the High Devil Canyon 1455 development. Four of the eight single-development alternatives are alternative heights for a development at the Watana site and are defined in terms of the maximum normal water surface elevation. Similarly, two alternative heights for a development at the High Devil Canyon site are included.

Exhibit E of the license application considers all aspects of project construction and operation in relation to probable impacts on fish, vegetation, wildlife and other physical, biological and socio-economic resources of the project area. That discussion is based on the Watana 2185 alternative combined with subsequent construction of the Devil Canyon dam and reservoir. The following sections of this memorandum consider the differences in impact if a lower maximum normal water surface elevation is selected at the Watana site or if other development concepts are selected.

Watana Alternatives

The majority of the anticipated impacts on terrestrial and aquatic resources resulting from the construction and operation of the two dam project (as described in the license application) are related to the first phase of development, the Watana 2185 dam and reservoir. The relative impacts of the Watana alternatives are therefore compared to those for the base case Watana 2185 development as discussed in Exhibit E. Lowering the maximum normal water surface elevation at the Watana site from 2185 feet to 2100, 2000 or 1900 feet would result in the following changes in project characteristics:

a) less area inundated,

b) less borrow material needed,

c) 1 to 3 years shorter construction period,

d) elimination of the potential for emergency releases to Tsusena Creek,

e) more modest remedial measures to seal the relict channel, and

f) less inherent capacity for flood control and less seasonal flow regulation.

These changes, in turn, will modify the impacts that are described in many sections of Exhibit E. Alterations of project height may also lead to alterations in installed capacity (but not the turbine discharge capacity) and project operation schedules which in turn will result in alterations in downstream flows. These downstream alterations are considered in a subsequent portion of this Appendix.

Area of Inundation.

Table 2 shows that lowering the reservoir from 2185 to 2100, 2000 or 1900 reduces the length of the reservoir by 5, 10 and 15 miles respectively, reduces the area by 26, 48 and 62 percent respectively, and reduces the active storage capacity by 32, 58 and 75 percent respectively.

to be revised

Exhibit E identifies five major impact issues directly related to the amount of area inundated by the Watana development and therefore to the planned normal maximum water surface elevation. These impact issues relate to:

A. Loss of grayling spawning and rearing habitat

B. Removal of vegetation

C. Removal of moose habitat

D. Inundation of Jay Creek Mineral Lick

E. Impacts on other wildlife.

A. Loss of grayling spawning and rearing habitat. The Watana 2185 reservoir will flood 54 miles of Susitna River mainstream habitat and 28 miles of tributary habitat, including 10.0 miles[a/] along Watana Creek, as well as portions of other tributaries. The primary long-term impact results from the loss

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[a/] 10.0 miles according to Table E.2.25 of license application (Exhibit E). Data derived from U.S.G.S. maps. Recent project maps show inundation to extend 54,650 feet of the creek or 10.4 miles.

of clear water tributary habitat that currently supports a substantial population of grayling. Future aquatic habitats within the reservoir area are not expected to support a significant grayling population (page E-3-121).[b/]

Identified measures to minimize impoundment impacts would be to "substantially lower the surface elevation of the reservoir or to maintain surface level during the embryo incubation period" (page E-3-171). It will not be feasible to maintain constant reservoir elevations during the incubation period (May and June), but the alternative Watana developments would substantially lower the surface elevation of the reservoir and thereby inundate correspondingly fewer stream miles of tributary habitat than the 28 miles inundated by the elevation 2185 development (Table 3). Deadman, Watana, Kosina and Jay Creeks would still be impacted by a reservoir at elevation 1900, but to a considerably smaller extent. Goose Creek has an elevation of approximately 2060 feet at its confluence with the Susitna River and would not be adversely affected by the two lower alternatives. Oshetna River would be inundated only by the Watana 2185 development.

[b/] Unless otherwise identified, page references are to Exhibit E of the license application as filed, February 28, 1983.

Table 3

PRINCIPAL TRIBUTARY STREAMS[a] INUNDATED BY WATANA RESERVOIR

Stream	Location		Length (miles) Inundated by Reservoir At			
	R.M.	Elevation	1900	2000	2100	2185
Deadman Creek	186.7	1,513	0.7	1.2	1.7	2.3
Watana Creek	194.1	1,552	6.1	7.7	9.2	10.4
Kosina Creek	206.9	1,670	2.2	3.2	3.9	4.6
Jay Creek	208.6	1,700	1.7	2.3	3.0	3.6
Goose Creek	231.2	2,060	---	---	0.3	1.1
Oshetna River	233.5	2,110	---	---	---	1.9

[a] In addition, the lower portions of 39 smaller, unnamed tributaries will be inundated, for 0.1 to 3.9 miles, by all four alternatives with an additional 4, 12 and 13 tributaries inundated by the elevation 2000, 2100 and 2185 alternatives respectively.

B. Removal of Vegetation. Construction of the dam, spillway and impoundment areas for the Watana 2185 development will result in removal of about 36,600 acres of vegetation (page E-3-225). A reduction in the total reservoir area associated with the smaller projects will mean a corresponding reduction in total area requiring removal of vegetation. The Watana 2100, 2000 and 1900 alternatives would result in preservation of 9,700, 18,000 and 24,000 acres of natural vegetation, respectively.

C. Removal of Moose Habitat. Removal of vegetation for the Watana 2185 development will reduce the carrying capacity of the spring and winter range by the equivalent of 266 moose. In years of average snowfall, the impoundment zones are most important as a source of early spring foods and as calving areas. These zones also contain several large areas of river valley bottomland with mixed spruce deciduous woodlands that provide critical moose habitat in years of heavy snowfall. Reduction of reservoir area, particularly in the length of mainstream and tributary stream inundated, will reduce the magnitude of this impact. A reduction in the extent of inundation along Watana may be particularly significant.

D. Inundation of Jay Creek Mineral Lick. Partial inundation of the Jay Creek mineral lick and blockage of access to the lick may reduce the carrying capacity of the area for Dall sheep. With the reservoir at elevation 2185, up to 42 percent of the surface area of the mineral lick will be inundated by the Watana impoundment (page E-3-512).

The lick extends from elevation 2000 to 2450, so lower elevations of the reservoir will inundate less of the lick area or may totally avoid it.

E. Impacts on Other Wildlife. Reservoir clearance and general ground disturbance associated with the Watana development will have adverse impacts on many other species of wildlife (pages E-3-512 to 517 and Tables E.3.149 to 158). Lower reservoir elevations with less needed clearing and general ground disturbance will reduce construction and inundation impacts on all wildlife species in the area.

Borrow Material. "Removal of floodplain gravel can cause erosion, siltation, increased turbidity, increased ice buildup caused by ground water overflow, fish entrapment, and alteration of fish habitat" (page E-3-155). Borrow material requirements for the dam are shown in Table 4. A project at elevation 2100 reduces the volume of the dam by 26 percent, at elevation 2000 by 53 percent and a development at 1900 by _____ percent as compared with the base case project with normal maximum reservoir elevation at 2185.

Borrow areas A and D are located in upland areas away from the reservoir. Borrow area E is a large alluvial fan deposit at the confluence of Tusuena Creek and ranges in elevation from a low of 1410 feet near the river to 1700 feet against the valley walls. Although the mined area will be rehabilitated to provide productive feeding and overwintering fish habitat following construction, some increased turbidity will doubtless occur from the mining activities. Reducing the volume needed from this site will tend to reduce the extent and duration of turbidity and sedimentation in the river downstream during construction. Also, reducing the volume needed from this area will reduce impacts on the existing riparian habitat for moose and other species.

Table 4

DAM FILL VOLUMES
(million cu. yds.)

Project Elevation	Total Volume		Riprap	Core	Gravel & Filters		
	Volume	%Reduction			Volume	%Reduction	
2185	61.8	---	1.5	8.3	52	---	
2100	45.8	26	1.1	5.8	38.9	25	
2000	29.1	53	0.8	3.9	24.4	47	
1900	---	---	---	---	---	---	fill in
Borrow Area Source			A	D	E		

Shorter Construction Period.

Many project impacts discussed in Exhibit E are essentially time dependent in that the shorter the construction period, the less the cumulative impact. Of particular concern is increased hunting and fishing pressure and the general disturbance that will occur throughout the construction period. Reducing the dam elevation and therefore the construction period will thereby reduce the overall impacts. Some of the types of impacts which would be minimized in this way include:

Erosion

Potential for Oil and Hazardous Material Spills

Blasting

River Diversions

Reservoir Filling

Water Quality Changes

Maintenance of Access and Temporary Camps

Aircraft Disturbance

Emergency Flows to Tsusena Creek.

The present proposal includes an emergency spillway to pass flood flows in excess of 150,000 cfs (recurrance interval of less than once in 10,000 years). The emergency spillway will consist of a long straight chute excavated in rock and leading in the direction of Tsusena Creek. An erodible fuse plug at the upstream end will remain in place until overtopped.

Flows of up to 140,000 cfs in excess of the combined main spillway and outlet facility capacities may be released to Tsusena Creek, thus preventing overtopping of the main dam under Probable Maximum Flood (PMF) conitions. It is estimated that flows down the emergency spillway to Tsusena Creek would continue for a period of 20 days under PMF conditions.

At lower reservoir elevations, construction of this emergency channel would be more expensive than expansion of the main spillway facilities and therefore emergency spills would no longer be diverted to Tsusena Creek. Although such flows have an extremely low frequency of occurence, their removal from Tsusena Creek would remove a potential source of project impact.

Relict Channel.

An ancient channel, now filled, exists in the north bank of the reservoir approximately 2,600 feet upstream of the dam. This channel runs from the Susitna River gorge to Tsusena Creek and represents a potential source of leakage from the Watana reservoir. The controlling bedrock surface of the channel is at elevation 1740 and contains up to 454 feet of glacial deposits.

To preserve the integrity of the rim of the Watana 2185 reservoir and to control losses due to potential seepage, a number of remedial measures have been proposed. These measures will have a net result of disturbance to the vegetation and wildlife resources of that zone.

For lower reservoir elevations (2100 to 1900), needed remedial measures will be greatly reduced resulting in considerably less ground disturbance.

Flood Control.

The Watana 2185 project as described in the FERC license application is designed so that the powerhouse and outlet facilities, plus reservoir storage, will have sufficient capacity to pass the once in fifty year summer flood without operating the main spillway. During the flood, the reservoir will be allowed to surcharge to elevation 2193. By containing the fifty year flood without needing to use the spillway structure, problems related to nitrogen supersaturation and resultant fish kills will be minimized.

If a lower elevation for the Watana project is considered (2100 to 1900), project facilities should be designed so that equal protection from nitrogen supersaturation is provided, such as requiring up to 1 in 50 year floods to be passed without operating the main spillway. Sufficient flood routing studies will be necessary to assure that the project can adequately meet these criteria.

Devil Canyon Development (el. 1455, R.M. 152)

This development, as presently being considered, is virtually identical to that described in the license application. Incorporation of this development into the recommended project plan will not add differential impacts in relation to those described in the license application.

High Devil Canyon Alternatives (R.M. 156)

Two alternative heights are under consideration for a development at the High Devil Canyon site. One of these would be at the same elevation as the Devil Canyon Development (1455 feet) and thus would be comparable to it except that the reservoir would be four miles shorter with correspondingly less area and volume. Only Cheechako Creek and an unnamed steep (1175 ft/mile) creek would remain unaffected as compared with the Devil Canyon Development.

The higher of the two developments under consideration for the High Devil Canyon site would have a normal maximum water surface elevation at 1750 feet. This development would be located wholly within the reach of river inundated by the combined Devil Canyon - Watana developments as discussed in the license application. It would inundate the Watana site by 290 feet making future development there infeasible. Comparisons of the High Devil Canyon 1750 development with the Devil Canyon - Watana development, singly or combined, are shown in Table 5.

Table 5

COMPARISON OF DEVELOPMENTS

Characteristic	Development			
	HDC	DC/W	W2185	DC
Total Reservoir Area (Acres)	24,000	45,500	38,000	7,500
River Length Inundated (miles)	56	86	54	32
Active Reservoir Volume (10^6AF)	1.8	4.1	3.75	0.35

Environmenal impacts of the single High Devil Canyon 1750 development would be less than those for the combined Devil Canyon - Watana development and equal to or less than those for the Watana 2185 development alone. The High Devil Canyon 1750 development would inundate 3.3 miles of Tsusena Creek, including the falls (an aesthetic resource of the area) but would inundate less of Watana Creek and other upstream tributaries than any of the Watana alternatives (Table 6). As compared with the Watana 2185 development, the High Devil Canyon 1750 reservoir would spare a considerable amount of deciduous forest (birch and aspen) that exists along the south-facing slopes of the Susitna Canyon and along some of the tributaries. This is the only area of any extent that contains this type of habitat, and its associated avifauna, within the Upper Susitna Basin.

Table 6

INUNDATION OF TRIBUTARIES BY ALTERNATIVE DEVELOPMENTS (miles)

		Development		
Tributary	R.M.	HDC1750 a/	DC(HDC)1455 b/	Watana2185
Devil Creek	161.4	2.2* c/	1.4 *	N/A
Fog Creek	176.7	3.0*	1.0 *	N/A
Tsusena Creek	181.9	3.3*	0.2 *	N/A
Deadman Creek	186.7	0.5*	N/A	2.3 *
Watana Creek	194.1	3.7	N/A	10.4
Kosina Creek	206.9	0.9	N/A	4.6
Jay Creek	208.6	0.5	N/A	3.6
Total miles inundated		14.1	23.5	

a/ High Devil Canyon

b/ Devil Canyon

c/ All data as measured on 1:4,800 R&M topography unless noted with an asterix (*), in which case it is measured from 1:63,360 USGS maps. The larger scale maps are thought to be somewhat more accurate for our purposes

Vee Canyon Development (el 2330, R.M. 227)

The Vee Canyon 2330 development would inundate 36 miles of the Susitna River channel including 22 miles that would not be inundated by any other development. It would also inundate approximately 14 miles of Tyone River and approximately 2.2 miles of Oshetna River that would not be affected by any other development.

Possibly one of the most significant aspects of the Vee site is that much of the reservoir area has not been included in the area that has been studied to document baseline conditions and likely impacts of the Susitna project. In general, the baseline studies did not extend upstream beyond river mile 242 on the mainstream of the Susitna River, halfway up the length of the Vee Canyon Reservoir. Thus, detailed information is not available to make more specific comparisons of alternative project impacts. The Vee Canyon development would inundate a large area of river bottomlands upstream of the Oshetna River, particularly in the upper end of the reservoir area. This area is utilized by three sub-populations of moose that range in the northeast section of the basin and would otherwise be little affected by the Susitna Project. This additional inundated area is also used by the Nelchina caribou herd, particularly in moving to their calving grounds near Kosina Creek. This additional inundation would result in a greater potential for division of the Nelchina caribou herd's range, as well as inundating part of their range.

The Vee Canyon reservoir area is considered to be more important to some key furbearers, particularly red fox, than comparable lands affected by other developments downstream. On the other hand, impacts on birds and black bears would be less than that for comparable projects downstream.

The Vee reservoir would also flood the mouth of the Tyone River with a fluctuating and turbid pool and would, in all likelihood, severely decrease the present resident fish population of this, the main clearwater tributary of the Upper Susitna River. The Vee development would also create access to more wilderness area than would the downstream developments.

The area at and around the mouth of the Tyone River has a long history of occupation and use by man, and is a valued area by native people. Previous reviews of potential impacts of the

Vee Canyon development indicate there is a high potential for discovery of archaeological sites in the area to be affected.

The overall comparison presented in Exhibit E of the License application between impacts of the Devil Canyon - Watana Combination as opposed to the High Devil Canyon - Vee Development (Table E.10.19) shows that the former (Devil Canyon - Watana 2185) is preferable in all environmental characteristics except for potential impacts on birds and black bears. The High Devil Canyon - Vee combination would flood more floodplain habitat such as balsam poplar forests and more lakes and wetlands, while the Watana - Devil Canyon scheme would inundate more birch and aspen forests. In general, the incremental impacts of the Vee development outweigh any lessening of impacts from the High Devil Canyon development as compared with the Devil Canyon plus Watana 2185 development.

The potential impacts of the Vee development are particularly sensitive to relatively small changes in reservoir elevation. If the elevation were raised by 25 to 50 feet (to approximately elevation 2370, the reservoir would extend upstream on the Tyone River to include Susitna Lake and Lake

Louise and the surrounding area. On the other hand, adverse impacts of the development could be substantially reduced by lowering the proposed level of the reservoir to approximately elevation 2240. At that elevation, the reservoir would no longer reach the mouth of the Tyone River and its associated floodplain and wetlands. The reservoir would be reduced in length by approximately 14 miles along the Susitna River. Such a reduction would bring the upper limit of the reservoir downstream into the canyon area and away from some of the valuable moose and caribou habitat located further upstream. Such a reduction in reservoir elevation would also limit the reservoir to the area that has been covered by the baseline studies.

ENVIRONMENTAL IMPLICATIONS OF OTHER DESIGN CHANGES

During the development and costing of project alternatives, possible design changes for specific project features have been considered as well as the alternative development concepts and operational modes. The elimination of the emergency spillway to Tsusena Creek has already been considered in relation to lowering the Watana dam. Two other general changes in project design have also been considered that may influence project impacts. These are the possible substitution of concrete arch dams for the fill dams at all sites and elevations except for the Watana 2185 development and the elimination of the cone valves in favor of low level intakes leading to modified flip bucket discharge facilities that will disperse the flow and prevent nitrogen supersaturation. Environmental implications of these changes are considered below.

ARCH DAM VS. FILL DAM

The possibility of constructing concrete arch dams rather than fill dams is one option being considered. This appears to be a viable alternative at all locations except the Watana 2185 development where the lateral flair of the upper slopes would make this type of construction inappropriate.

The basic environmental difference between a fill dam and concrete arch dam at a given location is in their construction. In general, the arch dam will require one to two years less constructon time, and will require consideraly less borrow material than a comparable fill dam. These changes are similar to the changes previously discussed when considering lowering the normal surface elevation at the Watana development. In general, reducing borrow material and construction time requirements will both tend to reduce construction impacts at the site. Site specific factors will be incorporated into the environmental evaluation upon completion of preliminary design for the development alternatives.

DISCHARGE FACILITIES

The Alaska State Standard for man-caused gas saturations cannot exceed 110%. The incorporation of "cone-valves" into project design is repeatedly mentioned in the license application as the method of mitigation for gas supersaturation. Chapter 2 of Exhibit E (page E-2-187 and 188) states:

> "The avoidance of gas supersaturation will be achieved by the inclusion of fixed-cone valves as the "normal" outlet facilities.
>
> "By using the reservoir storage capacity coupled with the minimum summer powerhouse flow and the fixed-cone valve discharge, all

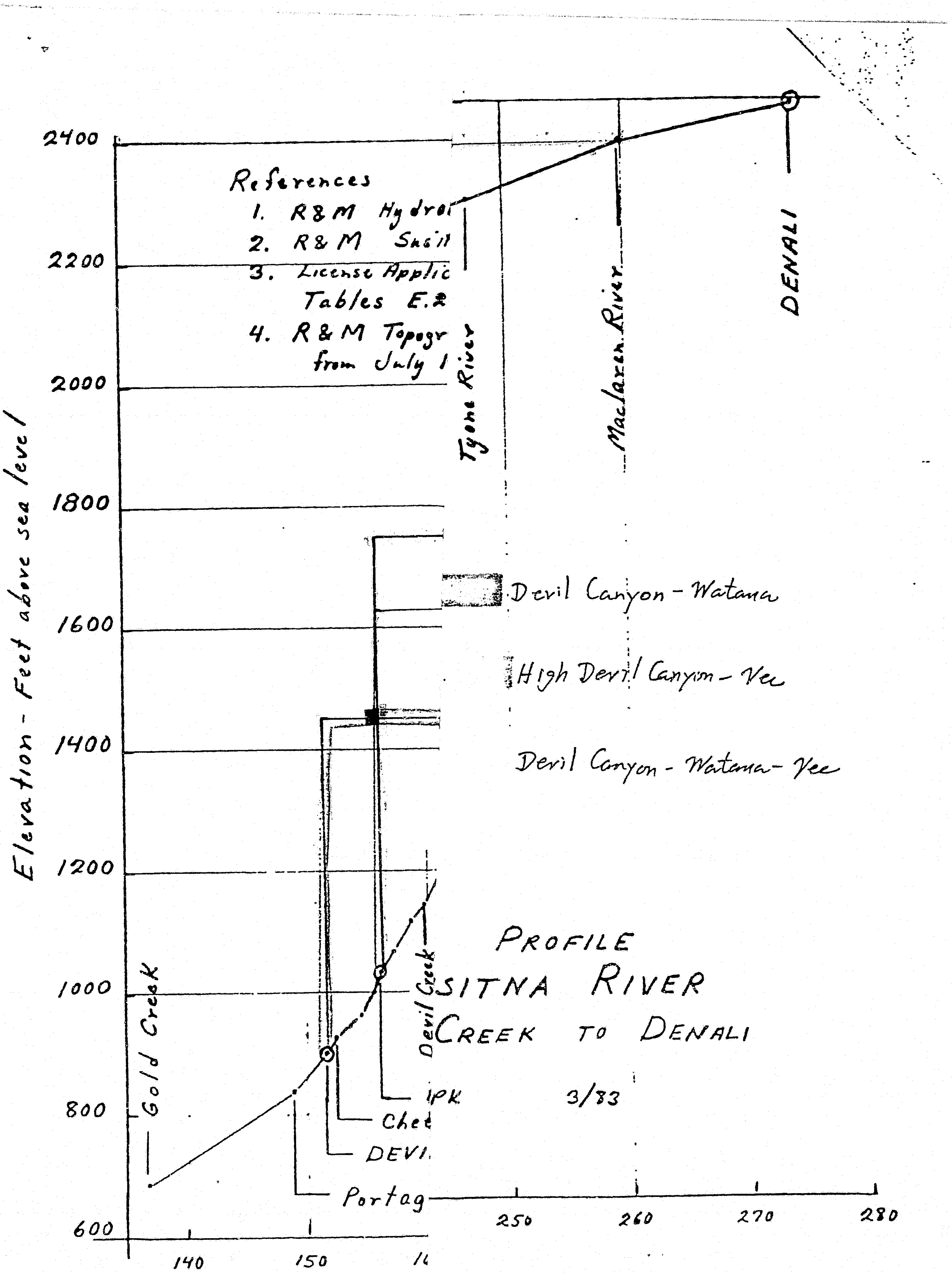
flow releases with a recurrence interval of up to 1:50 years will be discharged with minimum potential for nitrogen supersaturation. As previously described in Section 4.1.3, six 78-inch (2 m) diameter valves with a design capacity of 4000 cfs each, will be located approximately 125 feet (38 m) above normal tailwater levels. These valves will discharge the flow as highly diffused jets to achieve significant energy dissipation without a stilling basin or plunge pool."

"Little literature and no precedent data were available regarding the performance of fixed-cone valves in reducing or preventing supersaturated discharges. As such, a theoretical assessment of their anticipated performance was conducted based upon available studies of the aeration efficiency of similar Howell-Bunger valves (fixed-cone) and the physical and geometric characteristics of diffused jets discharging freely into the atmosphere."

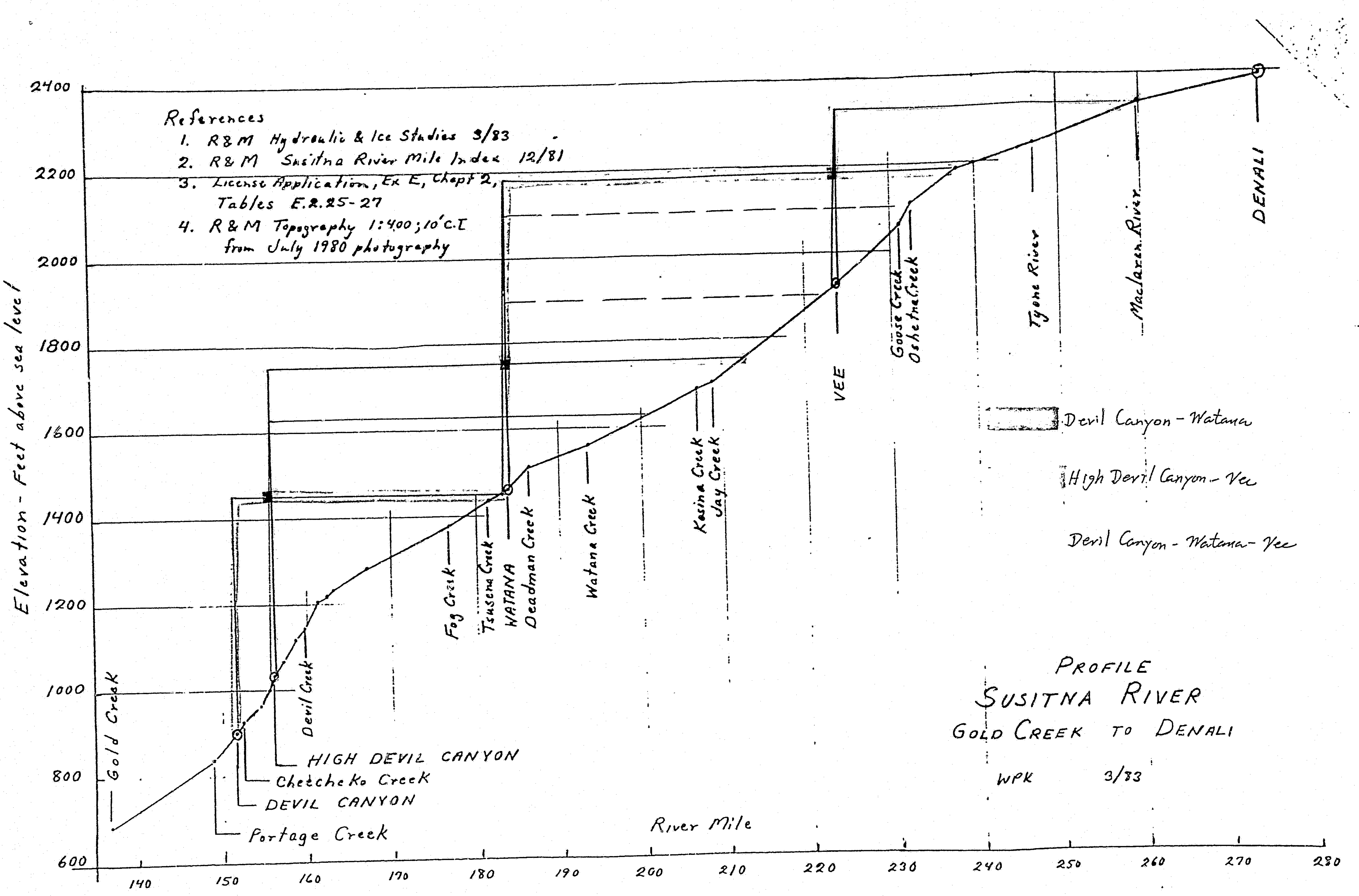
"The results of the assessment indicated that no serious supersaturation of nitrogen is likely to occur with flow releases through the valves. Estimated gas concentrations that would occur as a result of flow release are 101 percent at Watana and 102 percent at Devil Canyon. For releases of greater frequency at less discharge, the concentrations are expected to be slightly lower."

"To support these conclusions, a field test of similar valves was undertaken at the Lake Comanche Dam on the Mokelumne River in California (Ecological Analysts, 1982). The results of the tests indicate that the valves prevented supersaturation and, to a limited extent, may have reduced existing nitrogen concentrations. Flows of 4000 cfs with a dissolved nitrogen concentration of 101 percent at the intake structure were passed through four Howell-bunger valves. Gas concentrations in the discharge were 97 percent. At 330 feet and 660 feet (100 and 200 m) downstream, concentrations were 95 and 97 percent respectively."

Alternative design configurations are being considered whereby the cone valves, which were planned to discharge into the air approximately 105 feet above the river, may be replaced by a modified flip bucket specifically designed to disperse the flow and prevent penetration of the discharge plume more than 25 feet below the tailwater surface. Theoretically, this configuration will keep dissolved gas concentrations at or below those provided by the cone valves. The design of these discharge facilities will continue to limit the use of the main spillway to flow releases with a recurrence interval of no greater than 1 in 50 years. Definitive tests of the alternative discharge facilities and their ability to prevent gas supersaturation will be performed as part of the spillway model tests.



References
1. R&M Hydro
2. R&M Susit
3. License Applic
Tables E.2
4. R&M Topogr
from July 1
Elevation - Feet above sea level
2400
2200
2000
1800
1600
1400
1200
1000
800
600
140
150
250
260
270
280
Tyone River
Maclaren River
DENALI
Devil Canyon - Watana
High Devil Canyon - Vee
Devil Canyon - Watana - Vee
PROFILE
SITNA RIVER
CREEK TO DENALI
3/83
Gold Creek
Devil Creek
Portag
DEVI
Chet
PK


References
1. R&M Hydraulic & Ice Studies 3/83
2. R&M Susitna River Mile Index 12/81
3. License Application, Ex E, Chapt 2, Tables E.2.25-27
4. R&M Topography 1:400; 10' C.I from July 1980 photography
Elevation - Feet above sea level
2400
2200
2000
1800
1600
1400
1200
1000
800
600
River Mile
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
Gold Creek
Portage Creek
DEVIL CANYON
Chechecko Creek
HIGH DEVIL CANYON
Devil Creek
Fog Creek
Tsusena Creek
WATANA
Deadman Creek
Watana Creek
Kosina Creek
Jay Creek
VEE
Goose Creek
Oshetna Creek
Tyone River
Maclaren River
DENALI
Devil Canyon - Watana
High Devil Canyon - Vee
Devil Canyon - Watana - Vee
PROFILE
SUSITNA RIVER
GOLD CREEK TO DENALI
WPK 3/83